

CLAIMS

WHAT IS CLAIMED IS:

1. A method for supporting frame synchronization in a digital communication system, the method comprising the steps of:
mapping a codeword specifying framing information of a frame according to a signal constellation to output a data stream;
duplicating and demultiplexing the data stream into a first data stream and a second data stream;
modifying the first data stream according to a predetermined operation;
multiplexing the modified first data stream with the second data stream; and
outputting a physical layer signaling header corresponding to the frame based on the multiplexed data streams.
2. A method according to claim 1, wherein the signal constellation is independent of a modulation scheme of the frame.
3. A method according to claim 1, wherein the frame is a Low Density Parity Check (LDPC) coded frame.
4. A method according to claim 1, wherein the predetermined operation includes multiplying the first data stream with $\{-a\}$ or $\{a\}$, a being a predetermined constant.
5. A method according to claim 4, wherein the sign of the multiplier represents a portion of the framing information.

6. A method according to claim 1, wherein the multiplication results in bits of the first data stream interleaved with respective additional bits, the additional bits being phase rotated relative to the bits of the first data stream during modulation.
7. A method according to claim 1, further comprising the step of:
generating the codeword according to a first order Reed-Muller code.
8. A method according to claim 1, wherein the framing information specifies a modulation scheme, and a coding scheme.
9. A method according to claim 1, further comprising the step of:
scrambling the multiplexed data streams.
10. A method according to claim 1, wherein the signal constellation is according to a Binary Phase Shift Keying (BPSK) scheme.
11. A computer-readable medium bearing instructions for supporting frame synchronization in a digital communication system, said instruction, being arranged, upon execution, to cause one or more processors to perform the method of claim 1.
12. An apparatus for supporting frame synchronization in a digital communication system, the apparatus comprising:
a constellation mapper configured to map a codeword specifying framing information of a frame according to a signal constellation to output a data stream, wherein the data stream is demultiplexed into a first data stream and a second data stream;
a multiplier coupled to the constellation mapper and configured to modify the first data stream;
and

a multiplexer configured to combine the modified first data stream with the second data stream, wherein a physical layer signaling header corresponding to the frame is output based the multiplexed data streams.

13. An apparatus according to claim 12, wherein the signal constellation is independent of a modulation scheme of the frame.

14. An apparatus according to claim 12, wherein the frame is a Low Density Parity Check (LDPC) frame.

15. An apparatus according to claim 12, wherein the multiplier multiplies the first data stream with $\{-a\}$ or $\{a\}$, a being a predetermined constant.

16. A method according to claim 15, wherein the sign of the multiplier represents a portion of the framing information.

17. An apparatus according to claim 12, wherein the multiplication results in bits of the first data stream interleaved with respective additional bits, the additional bits being phase rotated relative to the bits of the first data stream during modulation.

18. An apparatus according to claim 12, further comprising:
a code generator coupled to the constellation mapper and configured to generate the codeword according to a first order Reed-Muller code.

19. An apparatus according to claim 12, wherein the framing information specifies a modulation scheme, and a coding scheme.

20. An apparatus according to claim 12, further comprising:

a scrambler configured to scramble the multiplexed data streams.

21. An apparatus according to claim 12, wherein the signal constellation is according to a Binary Phase Shift Keying (BPSK) scheme.
22. A method of supporting frame synchronization in a digital broadcast system, the method comprising the steps of:
 - encoding framing information of a frame by a forward error correction code to output encoded bits;
 - repeating each of the encoded bits; and
 - modifying the repeated bits according to a predetermined operation to transmit additional framing information.
23. A method according to claim 22, wherein the predetermined operation includes complementing the repeated bits.
24. A method according to claim 22, wherein the forward error correction code is a first order Reed-Muller code.
25. A method according to claim 22, wherein the frame is a Low Density Parity Check (LDPC) coded frame.
26. A computer-readable medium bearing instructions for supporting frame synchronization in a digital broadcast system, said instruction, being arranged, upon execution, to cause one or more processors to perform the method of claim 22.
27. A method for detecting the start of a frame, the method comprising the steps of:

receiving a data stream corresponding to a broadcast signal, the data stream including a unique word and a physical layer signaling header specifying modulation and coding information of the broadcast signal;
differentiating the received data stream;
multiplying the differentiated data stream with a predetermined multiplier;
summing outputs of the multiplication;
adding the summed outputs to yield a plurality of added values;
subtracting the summed outputs to yield a plurality of subtracted values; and
determining a maximum value among absolute values of the added values and the subtracted values.

28. A method according to claim 27, wherein the broadcast signal includes a Low Density Parity Check (LDPC) coded frame.

29. A method according to claim 27, further comprising the step of:
receiving the broadcast signal over a satellite communication channel.

30. A method according to claim 27, further comprising the step of:
outputting the maximum value to a detector configured to determine location of the unique word.

31. A computer-readable medium bearing instructions for detecting the start of a frame, said instruction, being arranged, upon execution, to cause one or more processors to perform the method of claim 27.

32. A device for detecting the start of a frame, the device comprising:
means for receiving a data stream corresponding to a broadcast signal, the data stream including a unique word and a physical layer signaling header specifying modulation and coding information of the broadcast signal;

means for differentiating the received data stream;
means for multiplying the differentiated data stream with a predetermined multiplier;
means for summing outputs of the multiplication;
means for adding the summed outputs to yield a plurality of added values;
means for subtracting the summed outputs to yield a plurality of subtracted values; and
means for determining a maximum value among absolute values of the added values and the
subtracted values.

33. A device according to claim 32, wherein the broadcast signal includes a Low Density Parity Check (LDPC) coded frame.

34. A device according to claim 32, further comprising:
means for receiving the broadcast signal over a satellite communication channel.

35. A device according to claim 32, further comprising:
means for outputting the maximum value to a detector configured to determine location of the unique word.

36. A method for recovering framing information of a frame transmitted over in a digital communication system, the method comprising the steps of:
descrambling a physical layer signaling code of the frame, the physical layer signal code being encoded according to a first order Reed-Muller code and interleaved; and
decoding the physical layer signaling code to derive coding rate, modulation format, and pilot structure of the frame.

37. A method according to claim 36, further comprising the step of:
deinterleaving the physical layer signaling code prior to the decoding step.

38. A method according to claim 36, wherein the decoding of the physical layer signaling code employs a fast Hadamard transform.

39. A computer-readable medium bearing instructions for recovering framing information of a frame transmitted over in a digital communication system, said instruction, being arranged, upon execution, to cause one or more processors to perform the method of claim 36.

40. A method for supporting frame synchronization in a digital communication system, the method comprising the steps of:

setting a search window length;

determining location of a peak within a frame over the search window length, the frame

including a unique word, a codeword, and a coded segment, wherein the codeword specifies framing information of the coded segment;

designating the peak location as a candidate;

verifying the candidate; and

declaring acquisition of the frame if the candidate is verified.

41. A method according to claim 40, further comprising the steps of:

decoding the codeword based on the candidate; and

predicting location of a next peak.

42. A method according to claim 40, wherein the framing codeword specifies a modulation scheme and a coding scheme of the frame.

43. A method according to claim 40, wherein the frame is a Low Density Parity Check (LDPC) frame.

44. A method according to claim 40, further comprising the steps of:
determining a modulation scheme associated with the frame;

setting the search window length according to the determined modulation scheme; and if the modulation scheme cannot be determined, setting the search window length to a default value based on the length of the frame.

45. A method according to claim 40, further comprising the step of: iteratively conducting subsequent peak searches with respect to other frames according to the set search window to yield a plurality of candidates, wherein the acquisition is declared after a predetermined number of candidates are successfully verified.

46. A method according to claim 40, wherein the peak corresponds to the unique word within the frame.

47. A computer-readable medium bearing instructions for supporting frame synchronization in a digital broadcast system, said instruction, being arranged, upon execution, to cause one or more processors to perform the method of claim 40.

48. A transmitter comprising:
an encoder configured to output a Low Density Parity Check (LDPC) codeword; and
a framing module configured to generate a LDPC coded frame in response to the LDPC codeword, and to append a physical layer signaling field to the LDPC codeword for specifying modulation and coding information associated with the LDPC coded frame, wherein the physical layer signaling field is encoded with a Forward Error Correction (FEC) code and has an embedded framing structure to assist with frame synchronization.

49. A transmitter according to claim 48, further comprising:
means for broadcasting a signal over a satellite communication channel, the signal representing the physical layer signaling field and the LDPC coded frame.